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Variability Studies in Isolates of Sheath Blight of Rice Caused by *Rhizoctonia solani* Kuhn

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Sheath blight is caused by *Rhizoctonia solani* which is known as a destructive disease and a major bottleneck for rice production in India as well as world. Eleven isolates of sheath blight pathogen were collected from major rice growing states such as Karnataka, Tamil Nadu, Kerala, Andhra Pradesh, Telangana, Odisha. *Rhizoctonia solani* is known to show high variability in terms of morphological, cultural and sclerotial characters. Hence study was conducted at Research and Development, Rallis India Limited, Bangalore to know the variability between the isolates which were collected from various locations. Studies on cultural variability revealed that colony colour varied from whitish brown to pale brown with slow, moderate and abundant growth patterns. Among the eleven isolates, majority were fast growing followed by medium growth. Size of sclerotia ranged from minimum of 1.00mm (Rs-9) to maximum of 1.97mm (Rs-8). Maximum isolates had excellent number of sclerotia (>60) produced per petridish. 3-4 days were required for initiation of sclerotia formation for all the isolates. Based on pattern of sclerotia formation, isolates produced sclerotia in central ring, scattered, central & scattered and central & peripheral manner. Sclerotia is formed either in aerial or surface mycelium or on both aerial and surface mycelium. Colour of sclerotia ranged from light brown to dark brown with rough texture.

Keywords: Rhizoctonia solani; sclerotia; isolates; colony.

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1. INTRODUCTION

Rice (*Oryza sativa* L.) is an important cereal crop and staple food for more than 50% of the global population. Extensive cultivation systems in rice crop to meet the global increasing demand, have brought a shift in pest and disease problems in rice. These biotic factors especially fungal pathogens are limiting the rice productivity to a greater extent. Sheath blight is one of the major fungal disease in rice owing to huge crop losses. It is caused by *Rhizoctonia solani* Kuhn (*Thanatephorus cucumeris* (Frank) Donk) sharing a major contribution for crop loss both in India and world [1,2]. Miyake report this disease for the first time in 1910 from Japan. In India, it was reported from Gurdaspur of Punjab by Chahal in 1963. The disease has established in many oriental countries such that it is called by different names *viz.,* "Oriental leaf and sheath blight", sheath blight, *Pellicularia* sheath blight, sclerotial blight and banded blight of rice [3]. Isolates of *Rhizoctonia solani* show tremendous variation in morphological and pathogenic characteristics [4]. Meena et. al*.* [5] reported great variation among the isolates with respect to mycelia and sclerotial characters. Variation of sclerotial characters like colour, size, texture were also studied by Kumar et. al*.* [6]. Seeing this wide range of variability, study was conducted to assess variability with respect to morphological and sclerotial characters among isolates.

2. MATERIALS AND METHODS

Sheath blight infected paddy samples were collected from various rice growing regions of India such as Karnataka, Tamil Nadu, Kerala, Andhra Pradesh, Telangana, Odisha. The pathogen was isolated and purified by following hyphal tip/ single sclerotial method [7]. Pure cultures were maintained in PDA slants and stored at 5^0C for future use. Cultural characters like colony colour, growth pattern and colony diameter were studied for all isolates. The colony colour was determined by using Munsell's soil color chart [8]. The colony colour was observed from bottom side of the culture plate. Growth pattern was recorded by visual observation according to hyphal growth – as abundant, aerial mycelium obscured surface mycelium and touched the cover of the Petri dish; moderate, aerial mycelium obscured surface mycelium without touching the cover, and slight- aerial mycelium did not obscure surface mycelium. Sterilized PDA media were poured on to Petri plates and allowed to solidify. 6 mm diameter mycelial discs from border of actively growing 3 day old culture plates of each isolates were taken and placed at the centre of Petri plates and incubated for 10 days at 27 ± 2^0C.

Sclerotial characters *viz.,* colour, texture, number, size, time taken for initiation of sclerotial formation, pattern of sclerotial production and location of sclerotia were studied. Texture of sclerotia was grouped as smooth and rough category. Number of sclerotia was categorized as group-1 (poor), group-2 (1-10, fair), group-3 (11-20, moderate), group-4 (21-40, good), group-5 (41-60, very good) and group-6 (>60, excellent). The diameter of the sclerotial bodies were measured with the help of Digital Vernier Calipers by harvesting 20 sclerotia in random from each replication and average diameter was calculated. Time taken for initiation of sclerotial formation was recorded in number of days. Pattern of sclerotial formation classified into 3 groups *viz.,* central, peripheral and scattered. Observation on location of sclerotia was taken on the basis of where actually the sclerotia is formed in the fungal colony *i.e.* Sclerotium formed within aerial mycelium, sclerotia formed at surface of the mycelium and other is sclerotia embedded in fungal mycelium itself.

3. RESULTS AND DISCUSSION

3.1 Colony Colour

Out of eleven isolates, four isolates (KARS-1, KARS -2, TNRS -2 and TRS-1) of *Rhizoctonia solani* showed whitish brown colour, four isolates (TNRS-1, APRS-1, APRS-2 and KERS-1) were of light brown colour and three isolates (KARS -3, ODRS-1 and ODRS-2) were of pale brown colour (Table 1). Singh et. al*.* [9] had also reported that colony colour ranged from whitish brown, light brown, yellowish brown, dark brown, pale brown to milky brown. Lal and Kandhari [10] also reported varied colony colours such as light brown, very pale brown, whitish brown, yellowish brown and dark brown. Colony colours like light brown, dark brown and grey were also reported by Mughal et. al*.,* [11].

3.2 Growth Pattern

Amongst the isolates of *Rhizoctonia solani*, six isolates (KARS -1, KARS -2, KARS -3, TNRS-1, TNRS-2 and APRS-2) were bound to show abundant growth and categorized into the group-1. Two isolates (APRS-1 and TRS-1) were found

to show pattern of moderate growth and categorized as group-2, whereas remaining three isolates (KERS-1, ODRS-1 and ODRS-2) were categorized into group-3 (Table 1). Slow, moderate and abundant growth pattern were also done by Pralhad et. al. [12], Lal and Kandhari [10] and Burpee et. al. [13].

3.3 Growth Rate

Based on growth rate, eleven isolates were categorized into three groups. Isolates (KARS -1, KARS -2, KARS -3, TNRS-1, TNRS-2 and APRS-2) with mean colony diameter of >65mm were categorized into group-1, medium growing isolate (TRS-1) was categorized into group-2 and remaining slow growing (30-49mm) isolates (APRS-1, KERS-1, ODRS-1 and ODRS-2) were categorized into group-3 (Table-1). Singh et. al. [9] had also reported growth rate of twenty five isolates as fast growing, medium growing and slow growing.

3.4 Size of Sclerotia

Based on the diameter of sclerotia, the isolates can be grouped as, Group-1 with a diameter range of 1.00-1.49 mm and group-2 with a diameter range of 1.50-1.97 mm. Maximum range of sclerotial diameter was observed in Rs-8 (1.97 mm) and minimum diameter was observed in KERS-1 (1.00 mm). Seven isolates (KARS -1, KARS -2, KARS -3, TNRS-2, KERS-1, ODRS-1 and ODRS-2) were categorized into group-1 having a diameter range between 1.00-1.49 mm. Remaining four isolates (TNRS-1, APRS-1, APRS-2 and TRS-1) were categorized into group-2 having a diameter range between 1.50-1.97 mm (Table 2). According to Basu et. al. [14], various isolates had a range of 0.23 to 1.91 mm sclerotial size. Similarly, Dath [3] and IRRI [15] also reported that the sheath blight isolates had diameter of sclerotia range from 1 to 3 mm.

3.5 Number of Sclerotia

Isolates were categorized into various groups based on number of sclerotia. None of the isolates were categorized into group-1 (poor), group-2 (1-10, fair), group-3 (11-20, moderate) or group-4 (21-40, good). One isolate (APRS-1) was categorized into group-5 (41-60, very good) and remaining isolates (KARS -1, KARS -2, KARS -3, TNRS-1, TNRS-2, APRS-2, TRS-1, KERS-1, ODRS-1 and ODRS-2) were categorized into group-6 (>60, excellent) (Table 2). Pralhad et. al. [12], Lal and Kandhari [10] and Singh et. al. [9] also categorized number of sclerotia into 6 groups.

3.6 Time Taken for Sclerotia Formation

Seven isolates (KARS -1, KARS -2, KARS -3, TNRS-2, APRS-2, TRS-1 and ODRS-2) took 3 days for initiation of sclerotia formation whereas remaining four isolates (TNRS-1, APRS-1, KERS-1 and ODRS-1) took 4 days for initiation of sclerotia formation (Table 2). Three to eleven days was the time required for sclerotia formation as studied by Meena et. al. [5]. Time taken for sclerotia formation also ranged from 3 to 6 days [9] and 4 to 8 days [12].

3.7 Pattern of Sclerotia Formation

Based on the pattern of sclerotia formation, isolates were classified into three groups. Sclerotium formed in the central ring was observed in three isolates (KARS -3, APRS-2 and ODRS-2). Sclerotium were formed in the scattered manner in four isolates (KARS -1, KARS -2, TNRS-2 and KERS-1) whereas three isolates (TNRS-1, APRS-1 and ODRS-1) showed sclerotial formation in both central and scattered manner. None of the isolates showed peripheral manner of sclerotia formation whereas one isolate (TRS-1) showed both central and peripheral manner of sclerotia formation (Table-3). Similar pattern of sclerotia formation *viz.,* central, peripheral and scattered was also studied by Pralhad et. al. [12] and Singh et. al. [9].

3.8 Location of Sclerotia Formation

Isolates were categorized into three groups, based on the location of sclerotia formation. First group included those isolates where sclerotium formed within the aerial mycelium. None of the isolates showed this pattern. Second group included those isolates where sclerotia formed at the surface of the mycelium (KARS -2, KARS -3, TNRS-1, APRS-2 and ODRS-2). None of the isolates had sclerotia embedded in fungal mycelium itself (Third group) whereas, six isolates (KARS -1, TNRS-2, APRS-1, TRS-1, KERS-1 and ODRS-1) recorded sclerotia formation in both aerial and surface mycelium (Table 3). Lal and Kandhari [10] and Singh et. al. [16] reported similar findings such as location of sclerotia as aerial, surface and embedded.

Table 1. Morphological variability of isolates of *Rhizoctonia solani* (Mycelial characters)

Isolates	Colony colour	Growth pattern	Colony growth diameter at different intervals (mm)				
			24hr	48hr	72hr	96hr	Mean
KARS -1 (Gangavathi)	Whitish brown	Abundant	52.50	69.20	90.00	90.00	75.43
KARS -2 (Mandya)	Whitish brown	Abundant	49.80	61.10	90.00	90.00	72.73
KARS -3 (Kampli)	Pale brown	Abundant	53.70	67.30	90.00	90.00	75.25
TNRS-1 (Thanjavur)	Light brown	Abundant	48.60	59.10	88.80	90.00	71.63
TNRS-2 (Coimbatore)	Whitish brown	Abundant	50.60	60.30	86.80	90.00	71.93
APRS-1 (Bapatla)	Light brown	Moderate	13.40	26.30	54.80	86.80	45.33
APRS-2 (West Godavari)	Light brown	Abundant	65.00	76.70	89.30	90.00	80.25
TRS-1 (Mokila)	Whitish brown	Moderate	36.30	47.20	78.30	90.00	62.95
KERS-1 (Ambalavayal)	Light brown	Slow	9.00	15.10	36.80	68.90	32.45
ODRS-1 (Jeypore)	Pale brown	Slow	16.25	36.25	59.25	81.63	48.34
ODRS-2 (Cuttack)	Pale brown	Slow	13.75	31.13	49.38	66.13	40.09
Sem±			1.00	1.15	1.04	1.03	
CD (5%)			3.99	4.60	4.15	4.11	

Table 2. Morphological variability of isolates of *Rhizoctonia solani* Sheath blight of rice (Sclerotial characters)

Isolates	Size of sclerotia (Avg. Dia in mm)	No. of sclerotia/ petridish	Time taken for sclerotia formation (days)
KARS -1	1.23	112	3
KARS -2	1.38	120	3
KARS -3	1.41	78	3
TNRS-1	1.76	90	4
TNRS-2	1.13	116	3
APRS-1	1.85	50	4
APRS-2	1.85	61	3
TRS-1	1.97	83	3
KERS-1	1.00	91	4
ODRS-1	1.40	98	4
ODRS-2	1.34	86	3
Sem	0.03	0.80	
CD (1%)	0.11	3.18	

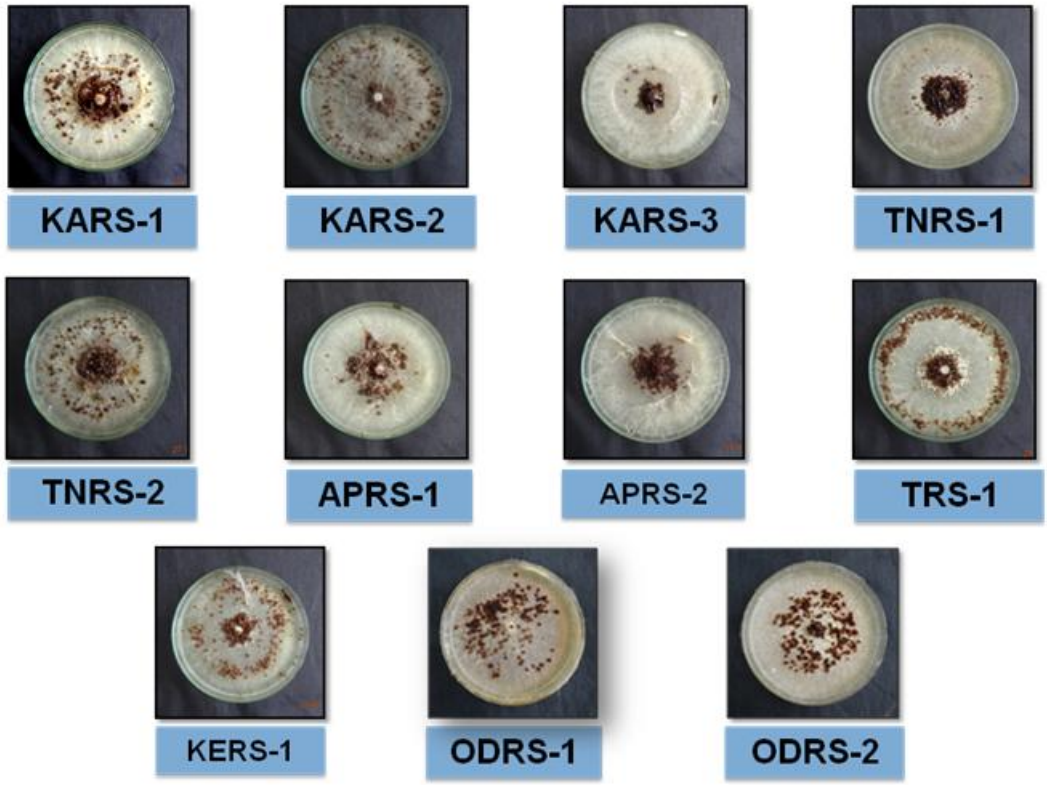

Plate 1. Isolates of *Rhizoctonia solani*

Table 3. Morphological variability of isolates of Rhizoctonia solani causing Sheath blight of rice (Sclerotial characters)

Isolates	Pattern of sclerotia	Location of sclerotia	Colour of sclerotia	Texture
KARS-1	Scattered	Aerial & surface	Dark brown	Rough
KARS-2	Scattered	Surface	Dark brown	Rough
KARS-3	Central	Surface	Dark brown	Rough
TNRS-1	Central & scattered	Surface	Dark brown	Rough
TNRS-2	Scattered	Aerial & surface	Dark brown	Rough
APRS-1	Central & scattered	Aerial & surface	Dark brown	Rough
APRS-2	Central	Surface	Dark brown	Rough
TRS-1	Central & peripheral	Aerial & surface	Dark brown	Rough
KERS-1	Scattered	Aerial & surface	Light brown	Rough
ODRS-1	Central & scattered	Aerial & surface	Dark brown	Rough
ODRS-2	Central	Surface	Dark brown	Rough

3.9 Colour of Sclerotia

Based on the pigmentation of the sclerotium, isolates were assigned into two groups. Ten isolates (KARS -1, KARS -2, KARS -3, TNRS-1, TNRS-2, APRS-1, APRS-2, TRS-1, ODRS-1 and ODRS-2) showed dark brown sclerotia whereas one isolate (KERS-1) showed light brown sclerotia (Table 3). Sclerotial colour ranged from brown, light/dark brown, black brown, chocolate brown, salmon and dark salmon in trials conducted by Hoa [17]. Mughal et. al. [11] reported sclerotial colours like light brown and dark brown.

3.10 Texture of Sclerotia

Based on the texture of sclerotia, the isolates were classified into two groups *i.e.* smooth texture and rough texture. All eleven isolates

belonged to rough category of sclerotial texture (Table 3). Sclerotial texture was also classified into two groups – smooth and rough by Hoa [17] and Singh et. al. [9].

4. CONCLUSION

Rice Sheath blight is one of the major destructive disease having its major contribution in crop losses. Because of its widespread nature, study of the pathogen variability with respect to various locations was of high demanding. From the study, it was revealed that *R. solani* isolate colonies produced light to pale brown colours with abundant to slow growth patterns. Isolates were also known to start producing slcerotia within 3-4 days in abundant numbers. But most of the isolates produced sclerotia in central and scattered manner majorly on surface in dark brown colour with a rough texture. Hence the pathogen is known to show high variability with respect to various morphological and cultural characteristics.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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